Pulsed Magnetic Field for Neutron and X-ray

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High Magentic Field Spin Science in 100 T
-High Field Neutron Experiments

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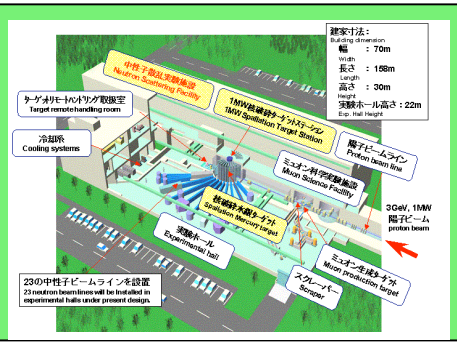
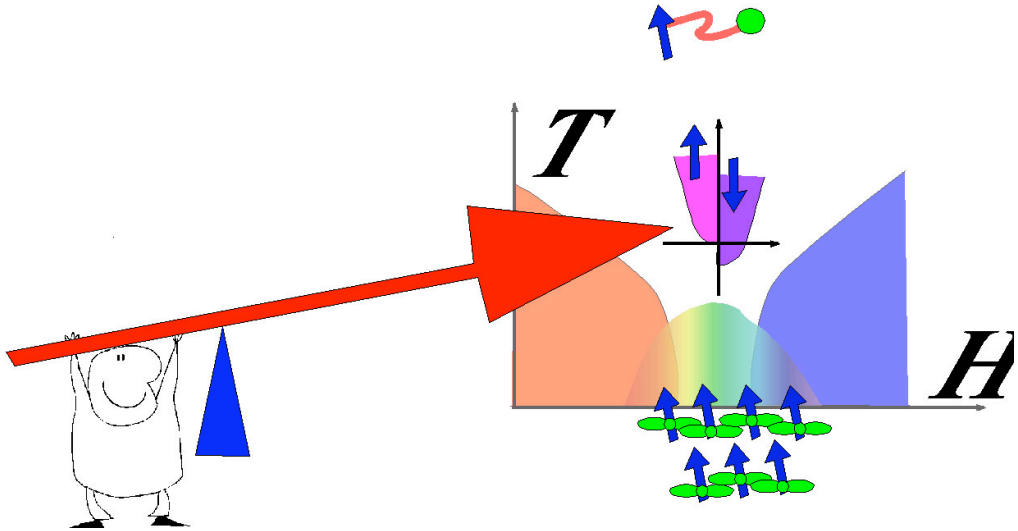


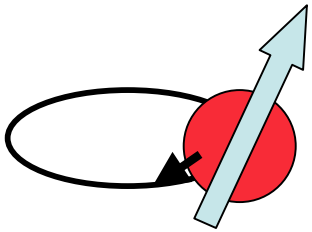
＝Control of Material by Spin

Various spectrometers
- Single Crystal
- Powder diffraction
- Polarization analysis
- Inelastic



Why magnetic field?

Couple to Spin and Orbital motion of electron

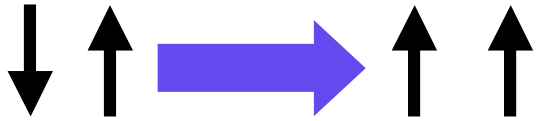


Precise Control

Soft

Time Structure

Low Field Control of Spin direction



At 100 T

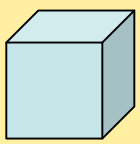
e	135 K
Mn^{3+}	540 K
Dy^{3+}	1000 K

Phase control

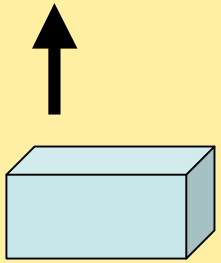
Non Mag.-Mag.

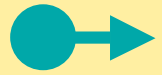
Structure

MI-transition

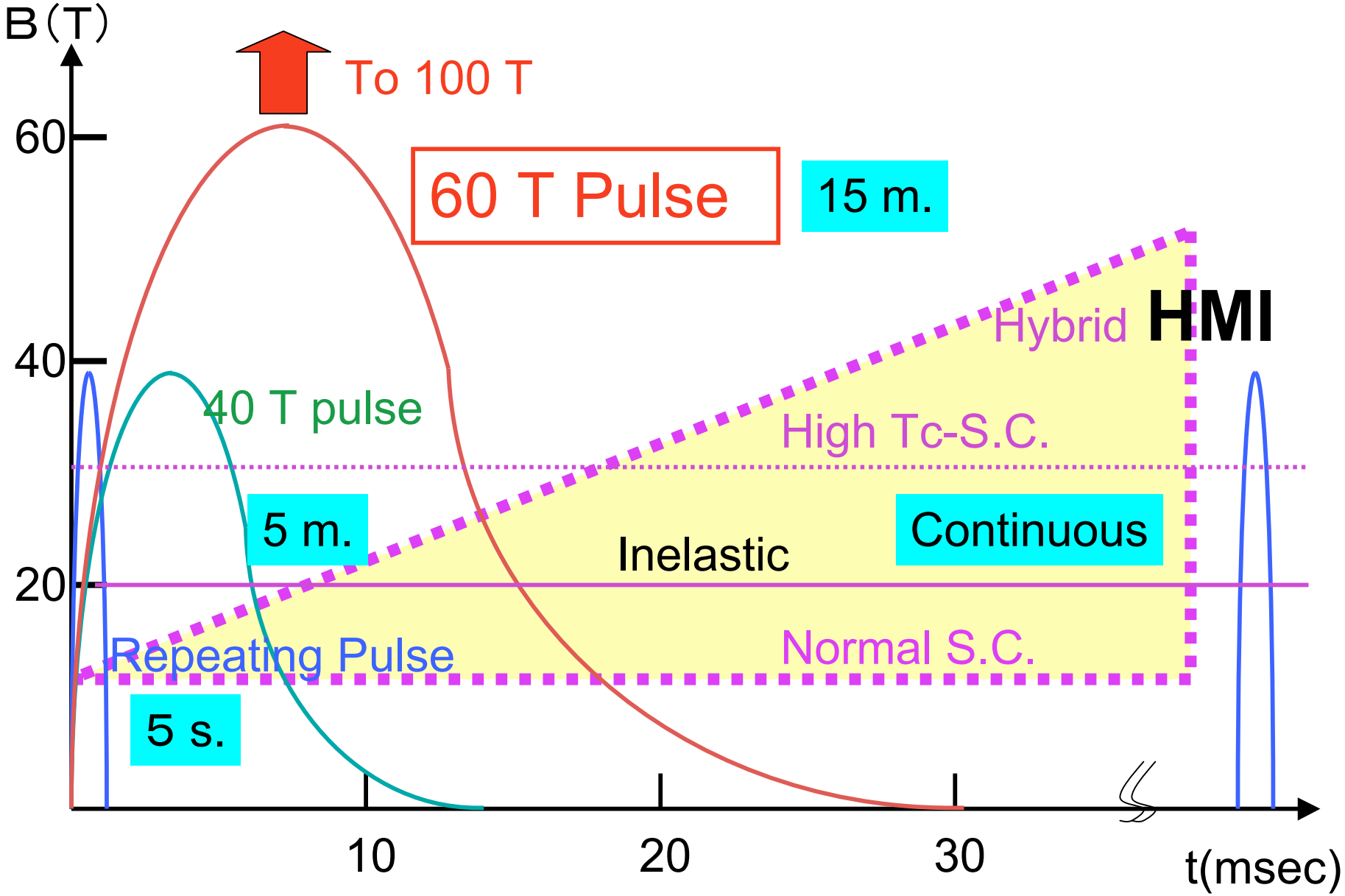


Drastic change

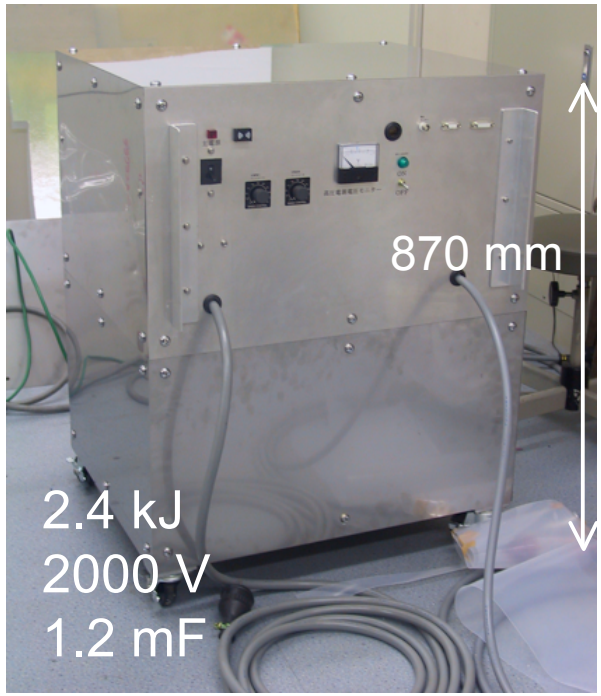




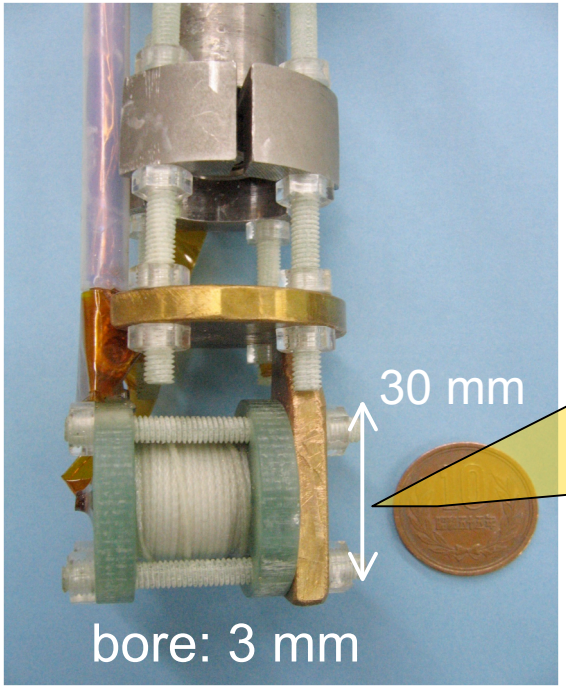
Various High field devices



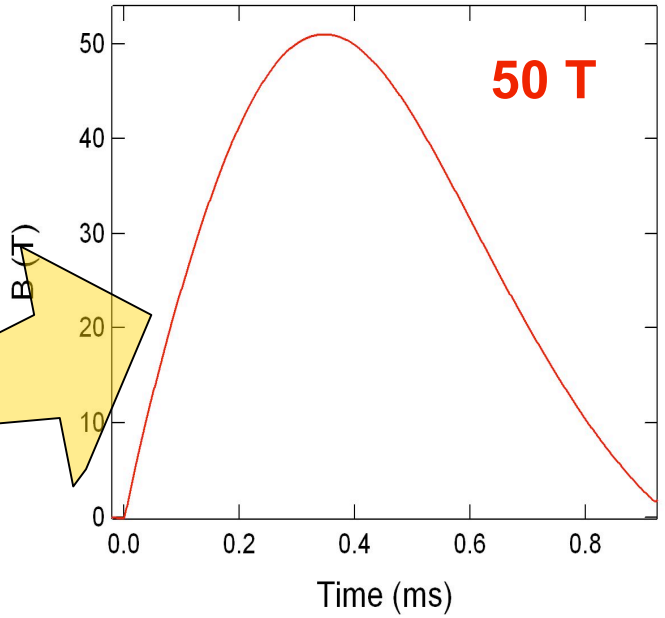
Miniature Magnet and Portable Capacitor Bank



Small Energy

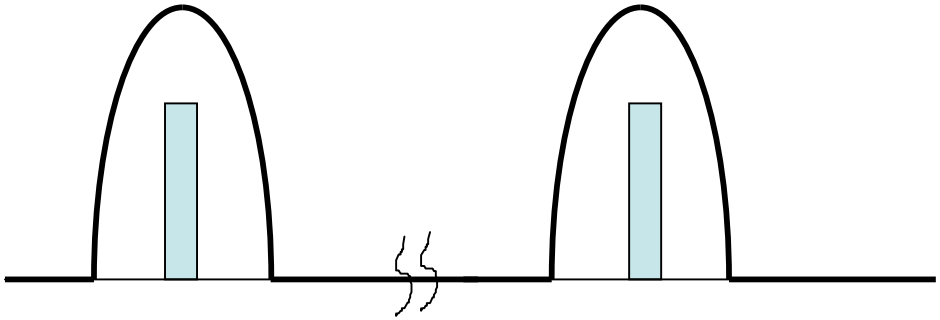


Small Space

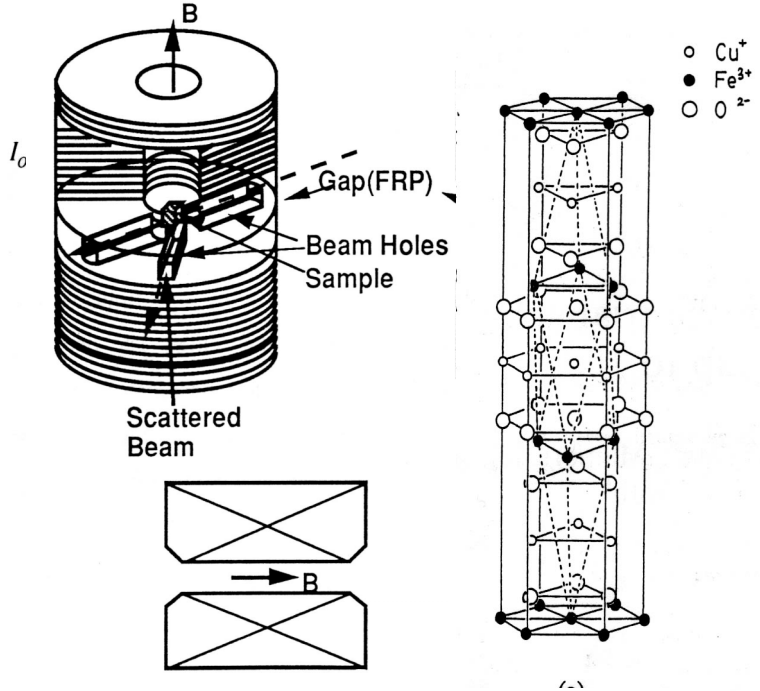


High Magnetic Field

ND in repeating pulsed magnetic field



- Pulse Neutron
- KENS in Tsukuba
- 25 T experiment



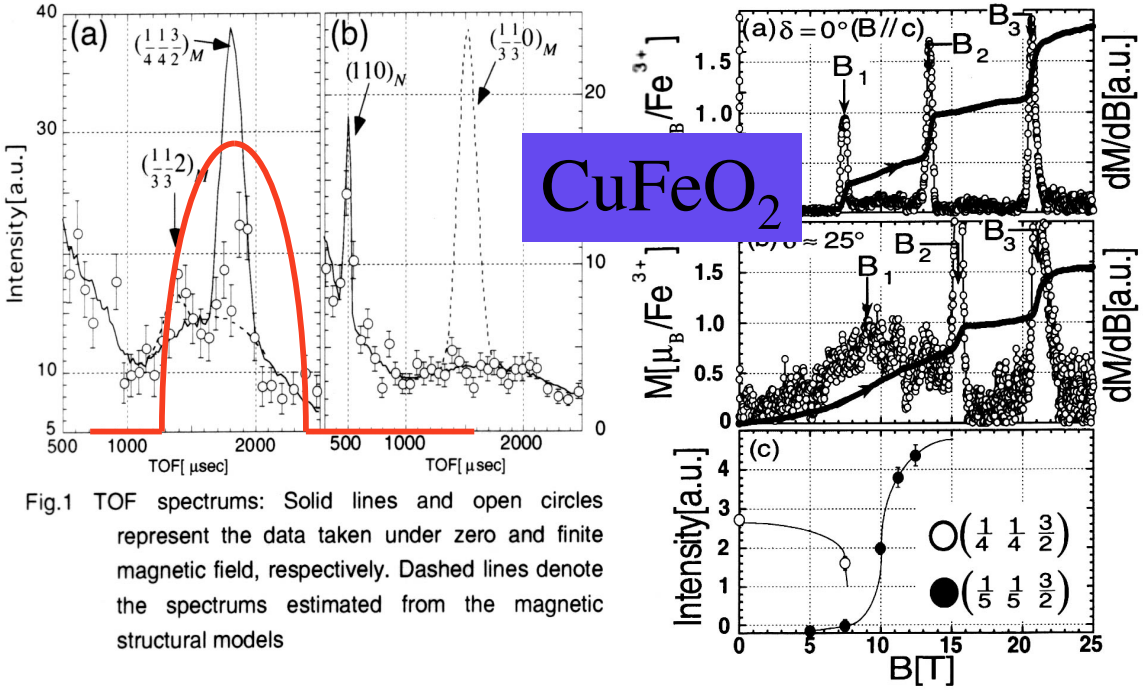
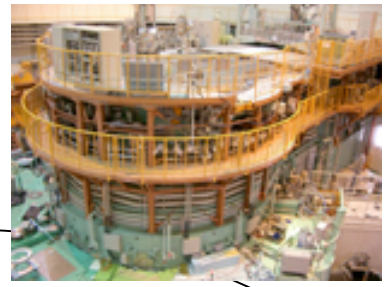


Fig.1 TOF spectrums: Solid lines and open circles represent the data taken under zero and finite magnetic field, respectively. Dashed lines denote the spectrums estimated from the magnetic structural models

Mini Coil for Neutron



The Highest Magnetic Field for ND

Repating :25T @ KEK

(Motokawa et al. 1989)

ND over 20T is still Difficult.

Reactor Facility

High Beam Flux

Beam Focusing is easier.

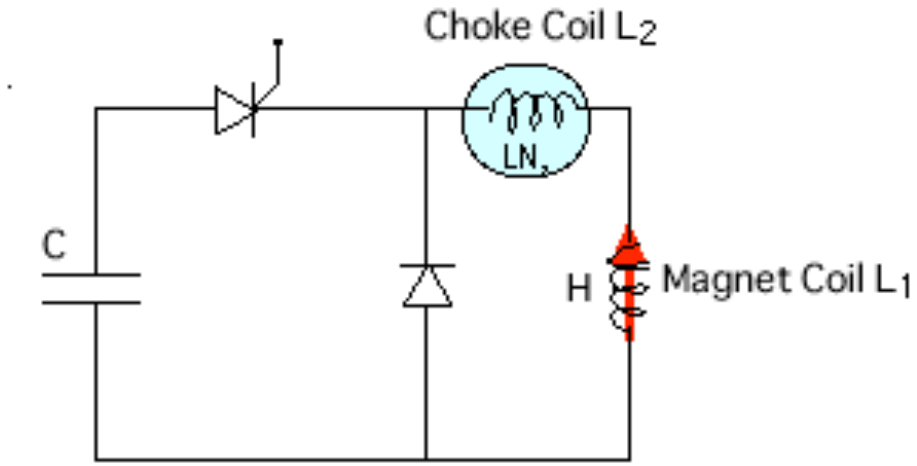
Development of Easier and more Diffusive Techniques

Target : H=40T

Goal: Observation of Magnetic Transitions by ~100 Shots Experiments

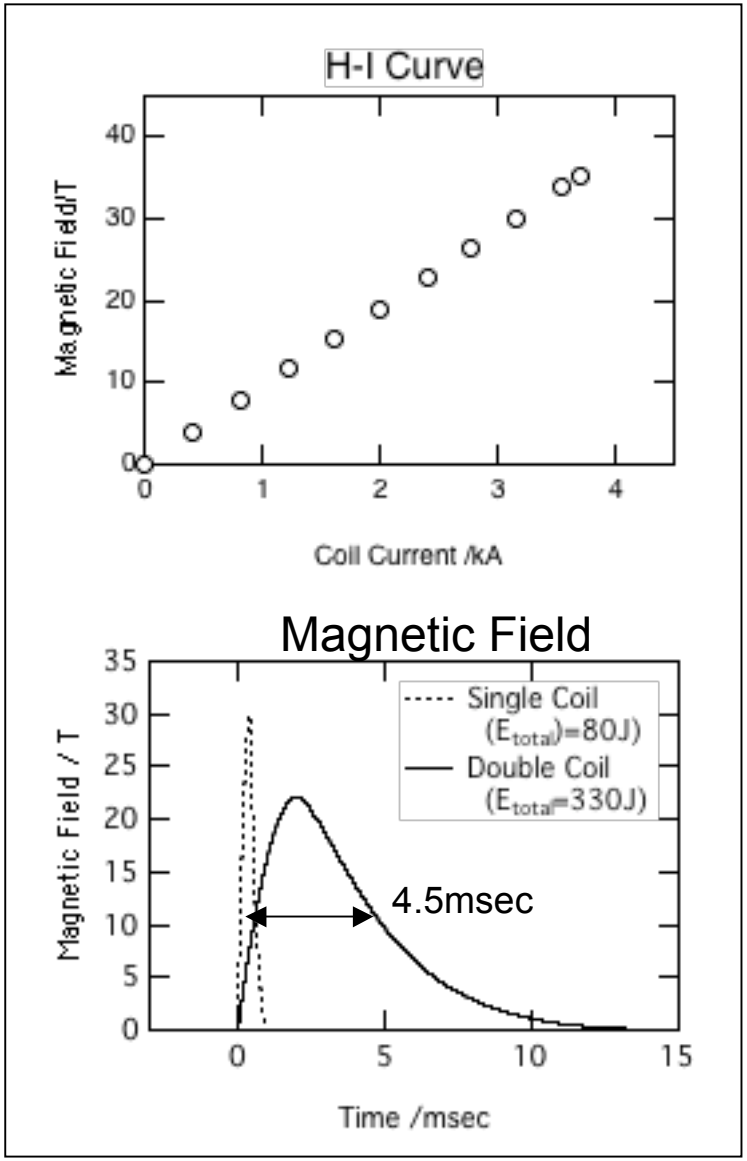
Development to J-PARC

Double Magnet System



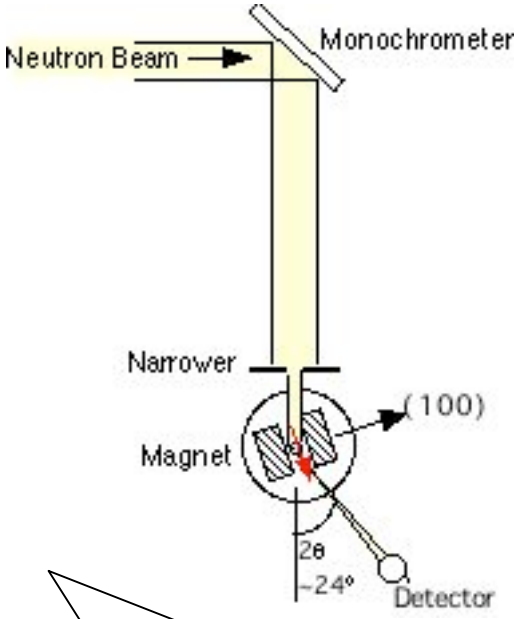
L_1~0.1mH, L_2~1mH
C=0.96mF (Short Pulse)
C=3.36mF (Long Pulse)

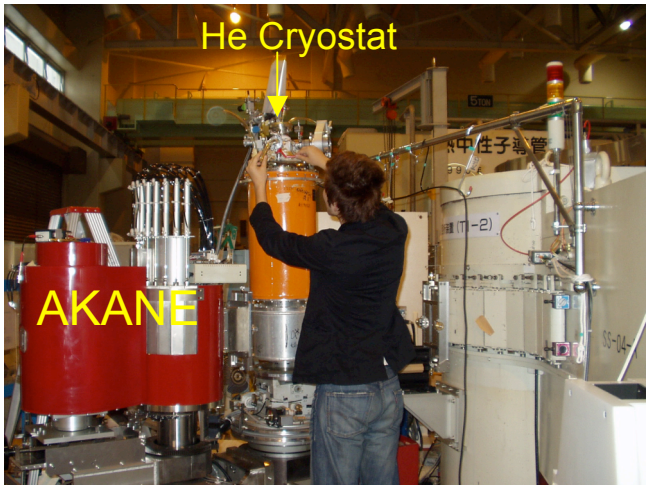
Longer Pulse
Low loss
Effective injection
Current limit
Design Freedom



Experimental

The Triple Axis Spectrometer, AKANE of Tohoku Univ.
@ JRR-3M, JAEA, Japan





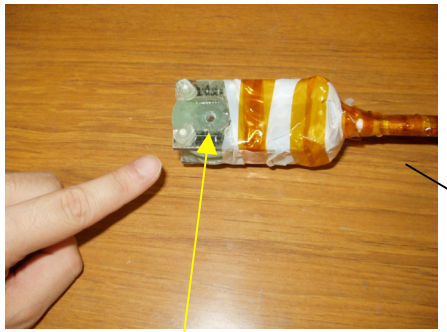
The coil & Sample were cooled in a liquid-He cryostat.

λ=2.0Å

Colimation: guide-Open-S-Blank-Blank

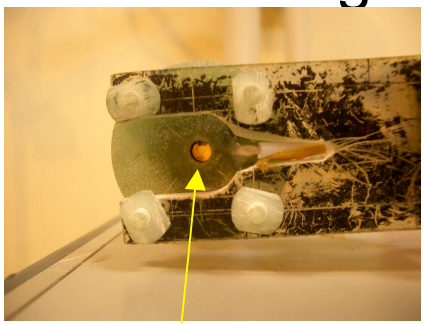
Scattering Plane: a*-c*

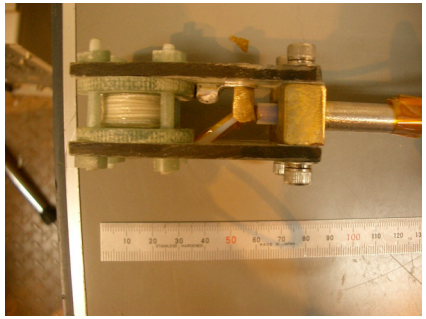
H//c



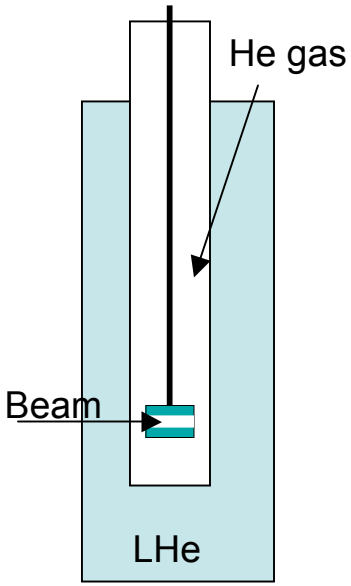
Sample Space
(ϕ5mm L10mm)

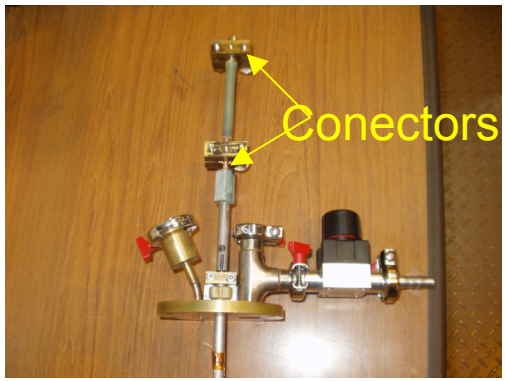
Magnet Coil (Cu-Ag)



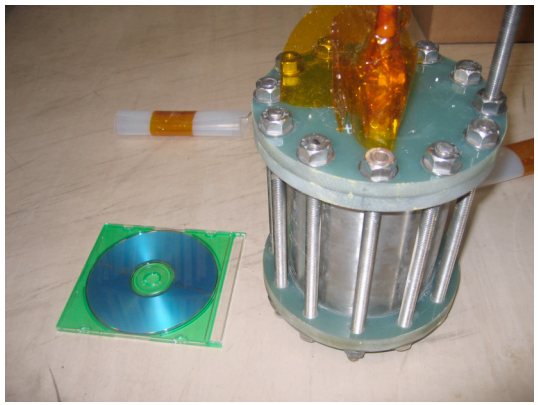


MnF_2

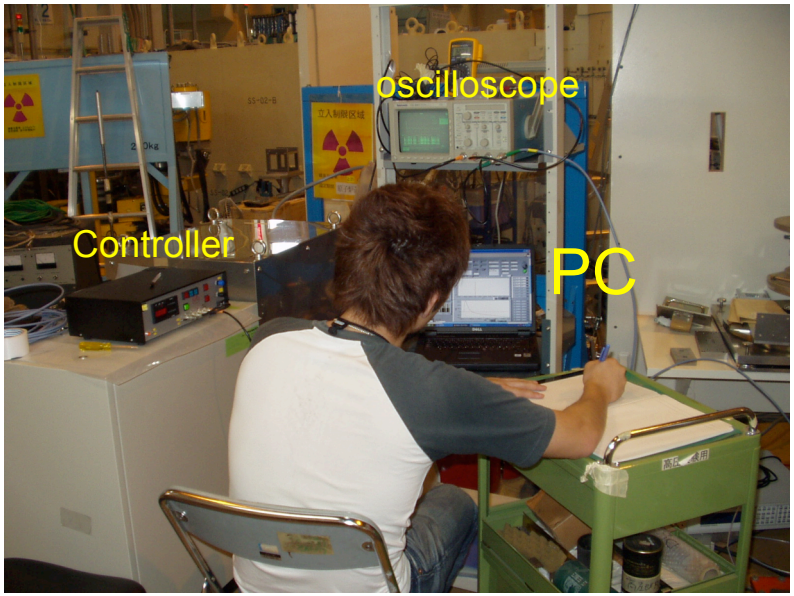




Choke Coil

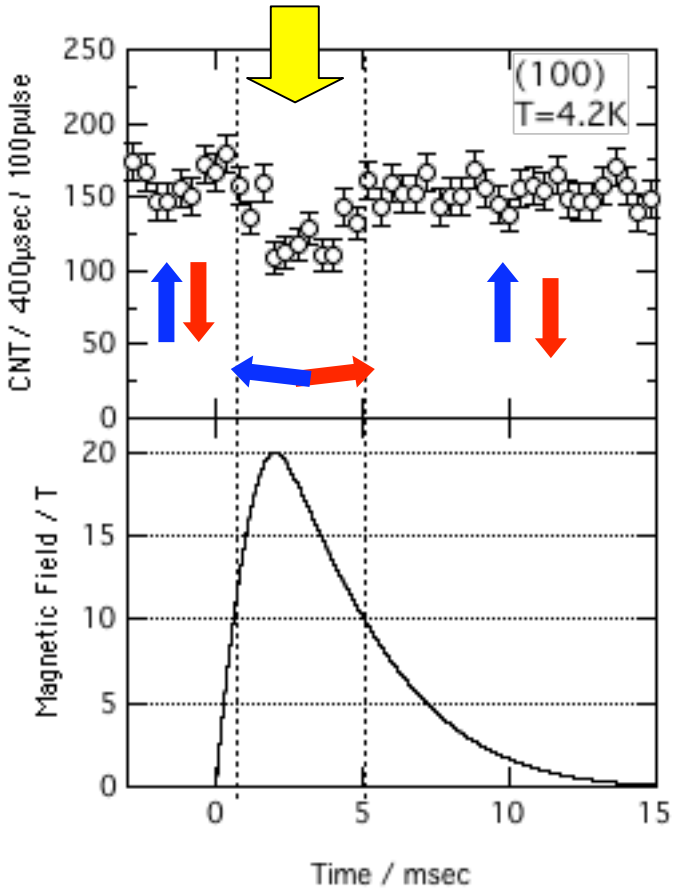


Compact Experiments!



Observation of Spin-Flop at 10T

Integration of (100) magnetic reflection after 100shots



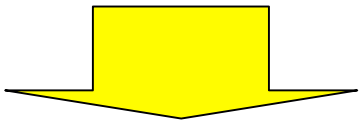
We succeeded in observing intensity change due to SF transition at 10T after 100 shots.

Pulse Interval: ~17min.

100 Pulse ~ 25hr.

Problems to be solved

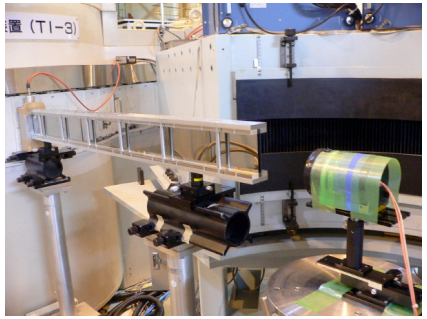
- Long Duration of experiments: ~25hr
  ⇒ Higher Beam Flux
- Coil Optimization, low resistive
- Cooling efficiency, Nitrogen coil
- Peak Profiles cannot be observed at the present.
  ⇒ PSD system

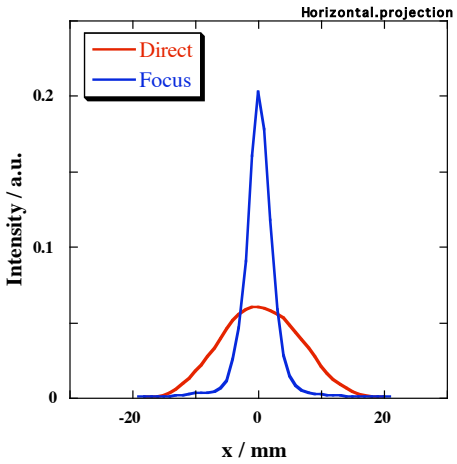


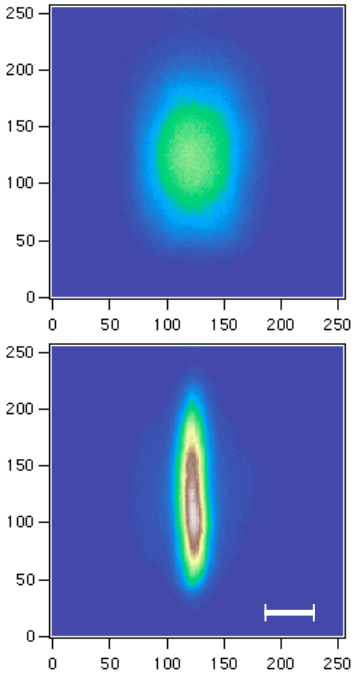
Practical Experiments

Enhancement of Efficiency

Beam Focusing by Neutron Super mirror

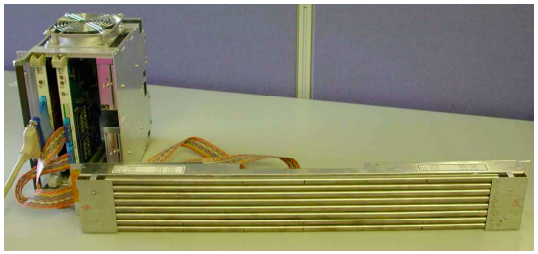


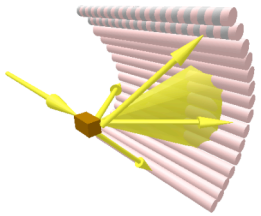




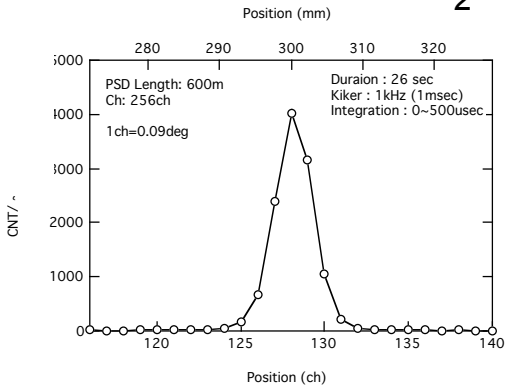
~3 times enhancement in real space

Position Sensitive Neutron Detector(PSD) System





Profile of 100 of MnF_2



PSD can observe Peak Profiles without step scan.

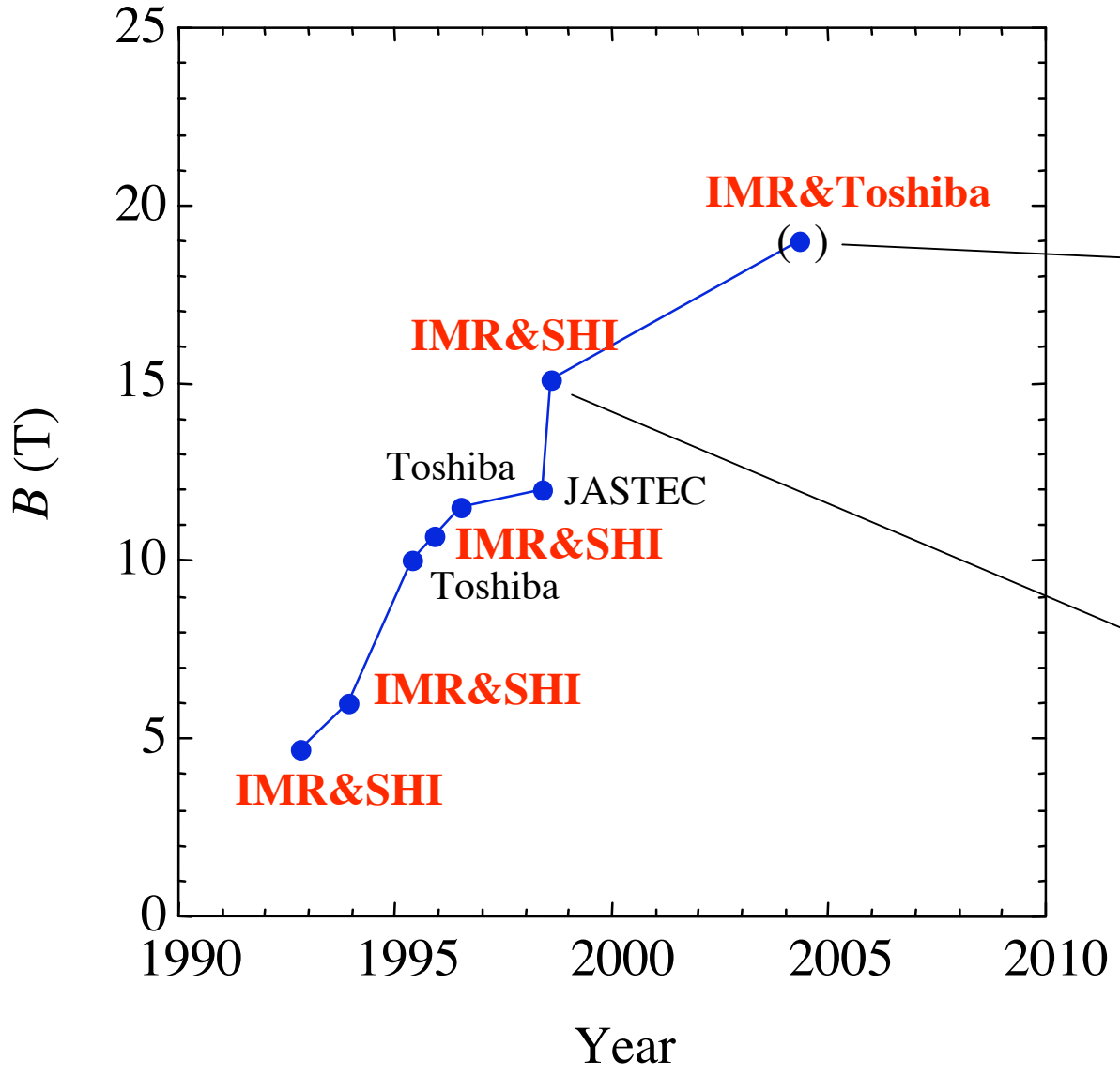
Short Summary

- We succeeded in test experiments in MnF_2 by ND after 100 shots with a 20T long pulsed magnet in a reactor facility.

- We also succeeded in generating 30T pulsed magnetic fields stably and safely on the spectrometer.

- By reducing the resistivity of the coils and Increasing the capacitance of the condenser, We can generate 40T magnetic Fields.

Cryogen-free magnet



18T Cyrogen Free Magnet

Maximum stress 53MPa@Bi2223 coil
258MPa@Nb_3Sn middle coil

Specifications

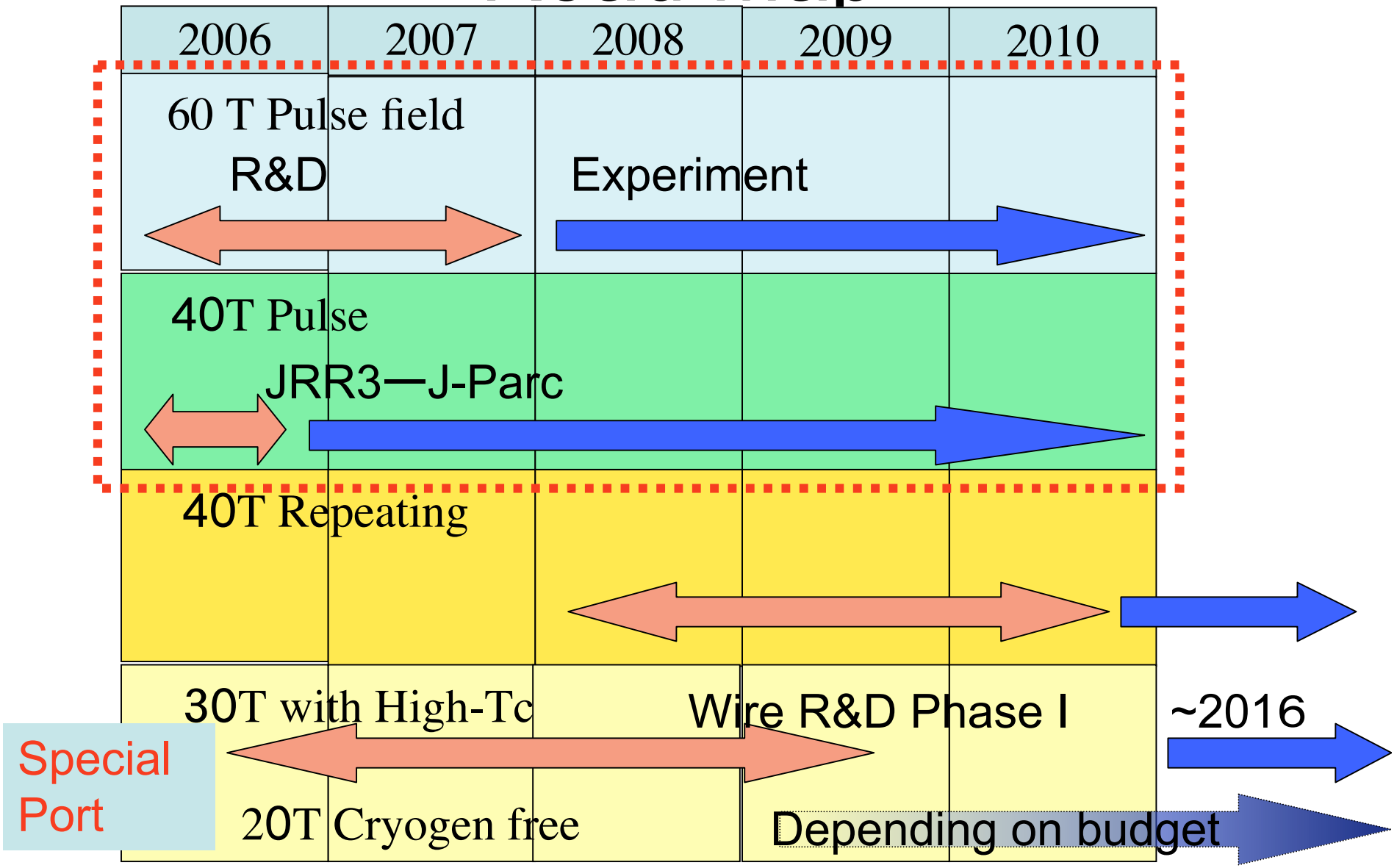
Magnet

- Bi2223 inner most coil (2.7T)
  - •co-winding with SUS tape
- Nb_3Sn middle coil (9.9T)
  - •internal tin Nb_3Sn inner coil
  - •high strength Nb_3Sn middle coil
  - •bronze route Nb_3Sn outer coil
- NbTi outer most coil (6.5T)

Cooling system

- single stage GM cryocoolers (100W@50K)x2
  for radiation shield, high-T end of CL
- GM-JT refrigerator (4.2W@4.2K)
  for coils, low-T end of CL

Road Map


2006
2007
2008
2009
2010
60 T Pulse field
R&D
Experiment
40T Pulse
JRR3—J-Parc
40T Repeating
30T with High-Tc
Wire R&D Phase I
~2016
20T Cryogen free
Depending on budget
Special
Port